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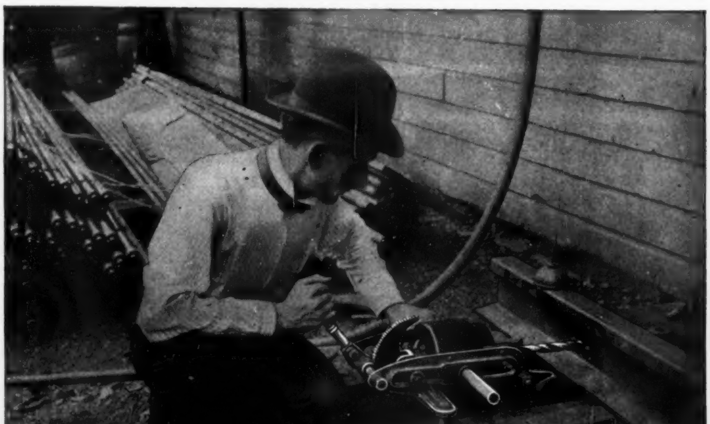
DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. III. NEW YORK, OCTOBER, 1898. No. 8



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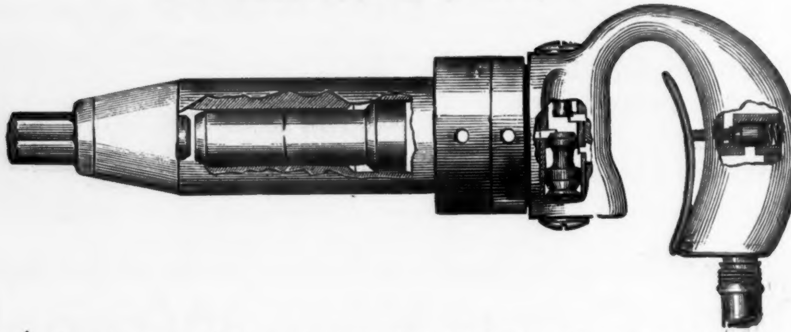

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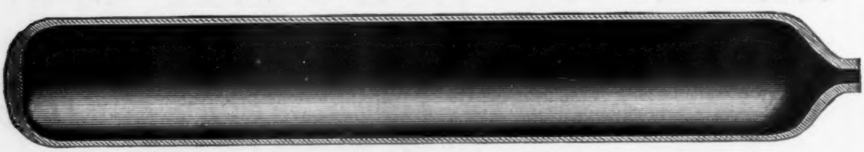

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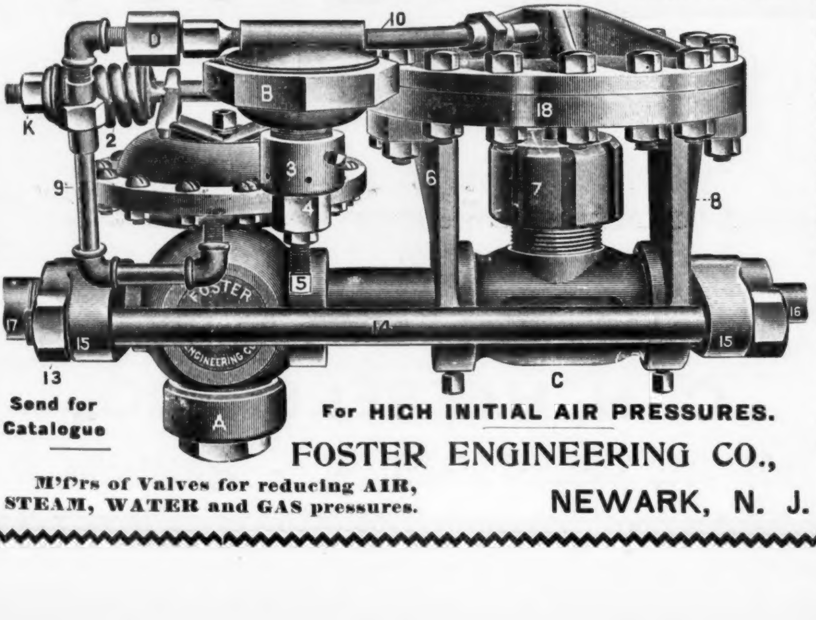

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Subscription, including postage, United States, Canada and Mexico $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York. London Office, 92 & 93 Fleet Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. III. OCTOBER, 1898. NO. 8.

THE publication of this magazine has progressed well into its third year, and we trust that our readers are pleased with the record which we have made in gathering interesting and valuable matter pertaining to compressed air. Its value in this respect is apparent, and it continues to perform this duty with serious persistence, and has moved up to a point where all agree as to its fairness and enterprise. With these points in its favor, the work of increasing our circulation and consequent influence goes steadily on, and considering the limited field that we have, the result is gratifiying and the future promising.

Friends of COMPRESSED AIR may assist in extending its usefulness by recommending it to others. They may send us names of persons likely to subscribe so that we can place sample copies in their hands and secure their patronage.

IN THE publication of matter our aim is to print only such as is of practical value, so that the reader may obtain from reliable sources information that will benefit him in his association with compressed air. The subjects cover a broad area and we invite our readers to supply us with descriptions of plants, experiences of interest, suggestions for improving the practice of compressed air in any line, announcements of new inventions, and inquiries concerning knotty problems. All these are helpful and we pledge them our best attention when we are so favored.

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You can be of service to this cause in many ways and promote your own interests at the same time by co-operating and we invite you to do so.

*Recent Experiments in Tamping Track by Compressed Air.

All appreciate the wonderful advance made in transportation by rail within the last forty years, in speed, safety and comfort.

In this country the engine has grown into a practically perfect mechanism, and the station and the coach to the convenience and comfort of a hotel. Bessemer's invention and the application to it of modern machinery of tremendous power, has made it possible to double the weight of the rail section without increase in its cost, though we now, seeking a low first cost, wrongfully merely squeeze the metal into the prescribed section, instead of as in earlier days, rolling it to a finish. And the joint problem, to the solution of which the inventive genius of the world has devoted itself for years, is still with us unsolved.

In one very material feature of railroad physics, of which I wish more particularly to speak, we have made no advance. As George Stephenson surfaced his track, so do we to-day, theoretically and practically, seeking to overcome the inequalities caused by train gravity in the foundation of our ties, by pounding more material under them in resistance to that gravity. We realize its general ineffectiveness, but few seem to appreciate its importance as an item in the general operating expense account.

In support of this assertion, there are within my knowledge, no statistics among those of any railroad, here or in Europe, segregating the expenditure for this unsatisfactory, irregular, endless and undoubtedly expensive work. We find the general cost per mile of maintenance of way, or distinguished as repairs and renewals, but this particular item appears to be considered as a necessary evil, an outlet for the employment of the time of trackmen, when there is nothing else to do.

As the condition of the track is the bedrock of the general repair account, the item of surfacing and its proportion of that account is worthy of examination and study.

Mr. Tratman, in his latest work (Railway Track and Track Work, 1897), has evidently made a strenuous effort in this direction. For the railways of this country alone, he gives for 1895, out of a total expenditure for operating expense of seven hundred and twenty-five millions, the cost of the work of one hundred and eighty-five thousand foremen and sectionmen, as sixty-nine millions, excluding rail and tie renewals, renewals and repairs of culverts, bridges, fences, buildings, and kindred structures, but he also evidently fails in finding the record of cost of this item.

We can try to arrive at it approximately from other sources.

Nearly all roadmasters and foremen fix the proportion of their pay roll expended on tamping as at least 50 per cent.

One hundred and eighty-five thousand foremen and section men, make an average of a little more than one man per mile, and their average pay is annually nearly or quite four hundred dollars—or by this estimate for this item, two hundred dollars per mile, nearly four cents per linear track foot.

Mr. Parsons, in his work on "Track" (1896), gives the expectancy of a man's accomplishment in careful surfacing with bars, in gravel ballast, taking fresh gravel conveniently distributed, from the gauge, as four feet per hour. But careful tests made within the last few years, show that section men do not make forty feet per day in such work, even when tamping back the dirty material from the road bed surface, instead of fresh material brought for the purpose, leading to the inference that Mr Parsons' record is that of a "spurt" made under his personal supervision.

In the most expansive tamping, and the most severe upon the men—coarse broken stone—foremen who have recently been asked to answer the question, say that in this work, done as well as it can be done, and as it should, of course, be done, one and one-half feet per hour is the expectancy of performance, equal to a cost of eight and one-third to ten cents per track foot. Actual timing has verified this, and it has been sustained by the opinion of higher officials in maintenance of way departments, though they assert that this work requires no repetition for a year or more.

In sand or gravelly loam ballast, where the tamping bar is useless, where shovel tamping is practiced and the best work not expected, nor obtainable, no figures as to cost are available. It is probably much less than the average given above of two hundred dollars per mile, and a total of thirty-seven million dollars per annum,

*Paper by Mr. F. R. Coates, Roadmaster N. Y. Div. N. Y., N. H. & H. R.R., read before the Annual Convention of the New England Roadmasters' Association, Revere House, Boston, August 17, 1898.

but probability is increased, in our belief, in the very much higher average on roads that expect the best results and strive to attain them.

There ought to be a better way to do this work--cheaper, easier for the men, and more even and permanent in its results.

In track surfacing we now expend an undetermined amount of time and money in tearing out the settled ballast until we expose the lower face of the depressed ties, and then raising them to the required level we drive material under them for a new foundation, and necessarily in doing so, disturb or destroy the old foundation. Then we refill and redress the ballast, and leave the track in the hope that the new foundation will prove as good as the old one made by train gravity, for the locomotive is the final tamper, its twenty tons weight on each tie finds all the inequalities of men's tamping, and will compact each tie's foundation until full resistance is met, without consideration for the work done by the men.

We all recognize this, and none will question that train gravity is the inevitable final tamping agent, and the best one, if it can be availed of and relied upon to do the work, and this is a question of creating the conditions necessary to its utilization

Theoretically, it would appear that if depressed ties or tracks were raised to the desired level, first removing only the ballast at the ends of the ties, there would be exposed the cavaties beneath the ties requiring filling, their base and walls already compacted to the susceptible limit of the material, be that material what it may, from broken stones, the best, down to "gumbo," the very worst. In compacting this foundation, train gravity and the elements have done all that they are capable of, and have done it better than is possible by any other means.

Thus far there has been but little departure from our usual custom, excepting that we have at the same moment raised and held both sides of the track, and under any method of tamping there is no doubt that this should always be done when needed.

If now these exposed cavities can be filled with a suitable material, we should expect that trains, having previously exhausted their power in compacting the foundation, could now only exert it on the new material just filled in between the tie and the old foundation and would be confined to the compressing of that material, thus conserving and availing ourselves of all the time and labor previously expended on the old foundation, which now we find ready for us, and thoroughly compacted.

The theory is indisputable ; the problem is to complete the process.

We will now consider the duties that ballast is called upon to perform, and find that they are fourfold.

First—It must be capable of draining the track.

Second—It supports the ties and thus holds the track to surface.

Third—It assists in preventing the track from creeping.

Fourth—It retains the line.

The question which now presents itself is how to surface the track with the least injury to the ballast and the bed it has made. From the foregoing it is evident that the only method is by working from the ends of the ties.

In England, on some of the roads, in order not to break up the foundation, the tie is lifted and gravel sprinkled under it from a small shovel shaped about like our tamping bar, the spade being a little larger. But the objection to this is, that though the train does the tamping, the side walls are broken down.

On some of the roads in this country, in order to preserve the bed and side walls, the ballast is dug out at the ends of the ties, the tie lifted up and gravel thrown or salted under. But this is not successful, as it is impossible for the men to get the material very far under the tie.

The most promising effort in this direction has been in experimental work during the past five years in the use of the air blast.

Its possibility once determined, the mechanical means were to be devised.

The conditions were :

First—Ready portability.

Second—Determination of the necessary proportions between appliances and work to be done.

Third—Adaptability to the use of all kinds of material and all conditions of surfacing work.

These requirements have, with few exceptions, been fairly met, though mechanical improvements will, with more extensive use, undoubtedly suggest themselves in the future as in the past.

The Root blacksmith's blower has thus far been found best adapted for conversion to this use. The mechanism is used by the ordinary track gang of four men, one or two of them being required to furnish

the power, and all engaging in clearing the tie ends during intervals of train waiting. Where the work is of sufficient magnitude, a double gang uses one machine on each rail, materially adding to the rate of progress of each. The on-looker is at once impressed with one fact—there is no possibility of "soldering" by any one man; each man fills his place, and the pause of one stops the work of all.

The mechanism having demonstrated its practicability, a serious problem is to develop the most economical method of placing suitable material convenient for use. In the ordinary picking up of low joints and loose ties in gravel road beds, the hand screens for excluding the particles too large to pass through the injector or to enter the cavity beneath the tie, seem to amply meet the requirement, and equally so where fresh material has been brought for more thorough work. Where the best of all ballast, stone, is available, the screening of the material to a size that can be used in the average cavity, say through a three-quarter inch screen, can readily be done at the breaker, and should be done without additional charge. If for use in coarse broken stone ballast, it has been found best to screen out the particles below one-fourth inch in a first filling, as a large part of the screenings under this size wastes among the interstices of the ballast. The dust is everywhere objectionable and breakers should not load it for track use.

The author of this paper is of the opinion that small stone is much more suitable for tamping than large, using it from three-fourths of an inch to one and one-half inches.

In the May, 1897, proceedings of the New York Railroad Club, the writer gave some experiments he had made with stone ballast as follows:

"A bucket holding twelve quarts of water was taken and filled level with the top with stone that would pass through a two and one-half inch ring; water was then poured in, and it held six and one-half quarts. Then a half inch smaller size was taken, and the same operation gone through with, and it held six and one fourth quarts. Then one and one-half inch ballast was taken, and the test showed that it held six quarts.

"In order to get a comparative estimate of the velocity with which water would drain through these different sizes, under similar conditions, the same bucket was used and four five-eighths inch holes bored in the bottom, ninety degrees apart. By pouring in the same amount in each case, which was six quarts, with the coarser stone it passed through in twenty seconds, with the next size in twenty-two seconds, and with the smallest in twenty-four seconds. A larger stone is not so good for tamping as one of such size as will pass through a one and one-half inch ring. At times the roadbed will get into such condition as to retain water, and in this event the smaller the stone the more solid will be the foundation and the less the amount of water it will hold.

"In view of these facts, it is conclusively proven that a small stone is much more preferable for ballast than a large one. And, further, if the specifications require the size of ballast to be such as will pass through a one and one-half inch ring, the large stones which meet the requirements in two dimensions, but are large in the third, will be kept out."

In other kinds of roadbeds, a clean ballast, free from earthy matter, ought to be used, and the amount required for this purpose is small in comparison with the amount required for full ballasting.

The mechanism in its present development is entirely a "surfacing," not a "track raising device," and the range of its applicability would seem to be from one-fourth inch up to one and one-half inch and the size of the material up to three-fourths inch.

Material passed through a three-fourths inch round screen can be used, but its flow is much slower than the smaller sizes, as also is the speed of its projections. This can be readily realized when we know that a fair speed of the compressor shows but eighth-tenths inch mercury pressure for the air which is conveying the material beneath the ties.

I have seen the performance of another application of the air blast to this use, which, dispensing with all the mechanism, gives greater projectile force, but I am requested not to speak of it in detail until its adaptability is better developed and determined. Where the power is available it increases the accomplishment of each man among the trackmen by the proportion of them now used in furnishing power on hand compressors. I am told also that the electrical experts are clear in their opinion that where the electrical current is available, a portable motor will furnish all the power needed; thus, while retaining the compressor, also correspondingly increasing each man's performance on the track.

In the experiments made at Stamford, Conn., on the N. Y., N. H. & H. railroad, two adjacent pieces of track, each fourteen rail lengths, were taken, they being under the same conditions of traffic. One was surfaced by men on a spurt and the other by the machine. The former attained a speed of five feet per man per hour, and the latter eight and two-tenths feet. In this, however, no allowance was made for screening the material, which would in all probability reduce the speed to eight feet per hour. In one year it required the expenditure of thirty-six hours of one man's time to maintain the surface of the portion put up by hand, and of two hours for that which had been surfaced by the machine.

Our present method is largely a matter of "strength and stupidity." The method under consideration is machinery action and its best service must be the outcome of practice, for there are conditions, which we have not been forced to notice in our present practice, which must be met, when learned, in the new.

For instance, in using gravel ballast, it is difficult to secure even work where squared and hewn ties are indiscriminately used. The cavity under the square tie is a perfect box, but the base of the hewn tie when raised from its bed leaves two vertical conical spaces above, too small to be reached and filled, but the restlessness of water-worn material—gravel—is excited by train pressure and the pebbles "churn" until the sandy portion has been forced upward, into every crevice. The remedy is to use the bar in downward tamping of the edges of the hewn ties, so as to close these small spaces at the side of the tie before the passage of a train, and it would seem advisable in using this method, in gravel or similar roadbeds, when the best work is desired, to always vertically tamp hewn ties.

In the application of the one use of air above referred to, the condition of the material seems to be of little importance, though the flow of dry material is, of course, the most rapid. In the use under consideration—the hand compressor—creating a back pressure in the descending ballast tube, bituminous cinder, because of its light gravity, is worked with difficulty; not a serious objection to those who believe it unfitted for tamping material in main track.

In using the hand compressor, the dryness of the material naturally contributes largely to the rapidity of its delivery.

I am also told that in friable material the tendency of the passage of a train on a "run off" to shake loose material into and obstructing the cavity under the tie has been noticed, as it has been frequently in stone ballast, but it is a difficulty easily remedied, though it retards the per foot per hour per man performance of the men.

Lengthened tie service is claimed for it, notably in coarse stone ballast, where many permit the bad practice of tamping the track up to grade instead of otherwise lifting it, frequent tamping resulting in champing off the tie base until the tie section assumes the shape of the letter U. Users of the air method find the splinters thus driven into the cavity a serious obstruction.

The method is believed to have solved the hitherto unsolved problem of the tamping of the interior of the steel tie. This, though of great importance upon the 35,000 miles of metal ties in Europe, requires no consideration from us at present.

As the cost of our present method is, so far as I know, practically unknown, it is too early to discuss the economy of the new method. Permanency of the work of the respective methods is a feature equally important with the first cost. Comparative tests for at least one year would seem to be necessary to determine these two points, though, I am reliably informed that in gravel roadbeds the speed obtained was far in excess of that procurable with bars and the work required no repetition until the relaying of the track three years subsequently.

Before making comparisons which would be of material value, a section of track at least a mile long should, in the writer's opinion, be surfaced with machinery. This is suggested in order that the handling of the material will be an important factor in calculating the expense. However, with the experimental work so far, the results are in favor of air tamping.

Sinking Cylinder Foundations in Valparaiso.

The following account of an important application of compressed air is given in "The Engineer."

Amongst the works designed and executed in the Port of Valparaiso for the Government of Chili in 1874-83 was a wrought iron mole or pier, for the discharge of ocean-going steamers of the largest class.

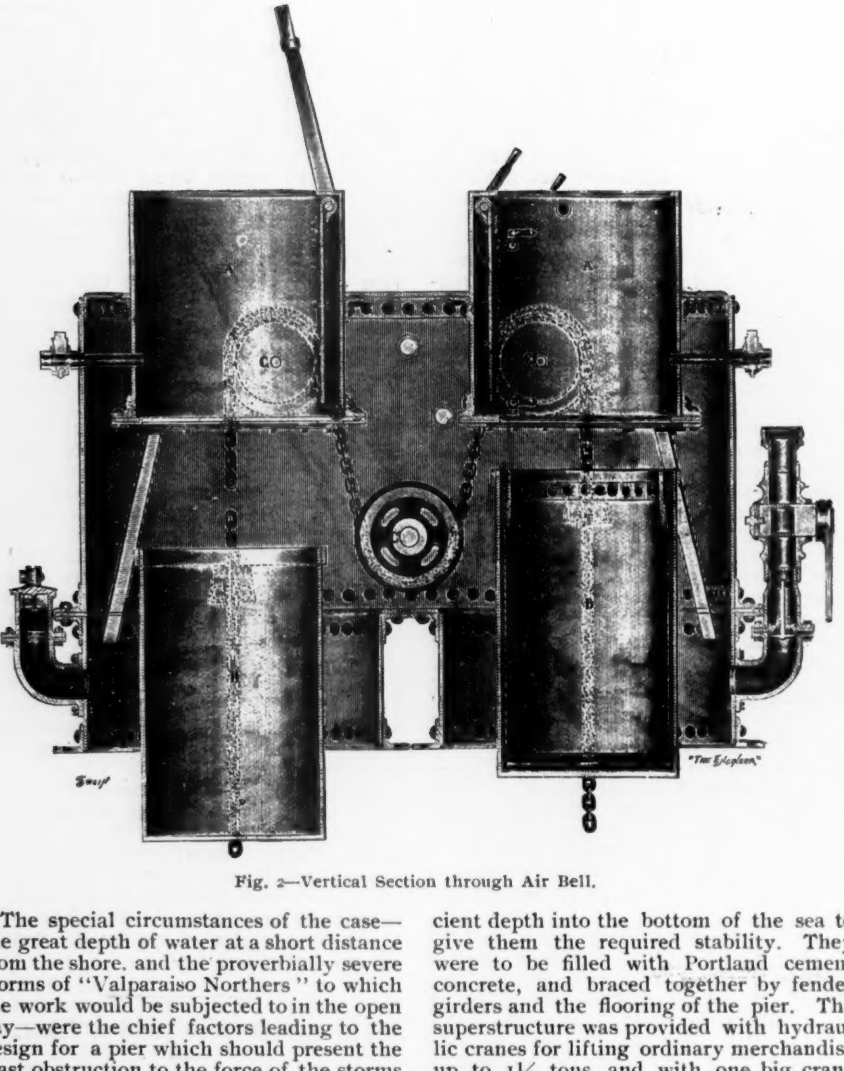


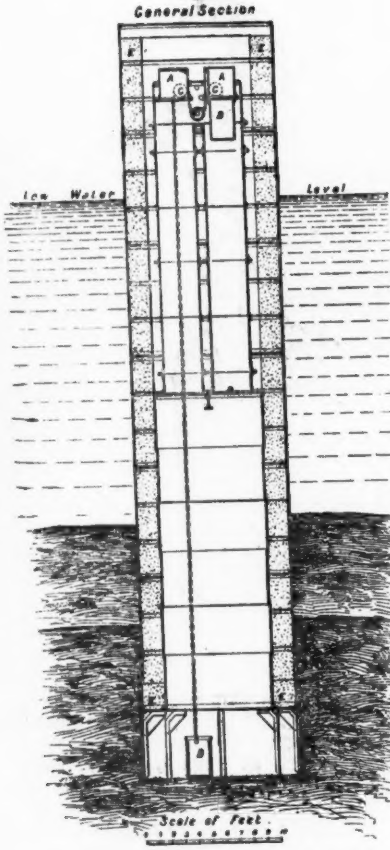
Fig. 2—Vertical Section through Air Bell.

The special circumstances of the case—the great depth of water at a short distance from the shore, and the proverbially severe storms of "Valparaiso Northers" to which the work would be subjected to in the open bay—were the chief factors leading to the design for a pier which should present the least obstruction to the force of the storms should be economical in construction considering the depth of water—42 ft. to 48 ft.—and should also possess the advantages of convenience and permanence. In view of the conditions to be fulfilled, it was decided to build a pier of wrought iron girders, supported on fifty-two wrought iron cylinder foundations, 11 ft. 4 in. diameter, placed at equal distances and sunk a sufficient depth into the bottom of the sea to give them the required stability. They were to be filled with Portland cement concrete, and braced together by fender girders and the flooring of the pier. The superstructure was provided with hydraulic cranes for lifting ordinary merchandise up to 1½ tons, and with one big crane capable of lifting exceptionally heavy weights up to 45 tons.

But it is not the purpose of this article to deal with the work as a whole, but with the pneumatic method used in sinking the cylinder foundations. The pneumatic apparatus used at Valparaiso was designed by the late Mr. John Hughes, M. Inst. C.E., at that time engineer-in-chief, who was

well-known in connection with this class of work from the time it was first used by him in sinking the foundations of Rochester Bridge in 1851. As will be seen by the accompanying illustrations, the latter form of apparatus presented many novel and interesting features. The cylinders themselves were formed of wrought iron, the bottom length of 15 ft. being riveted together

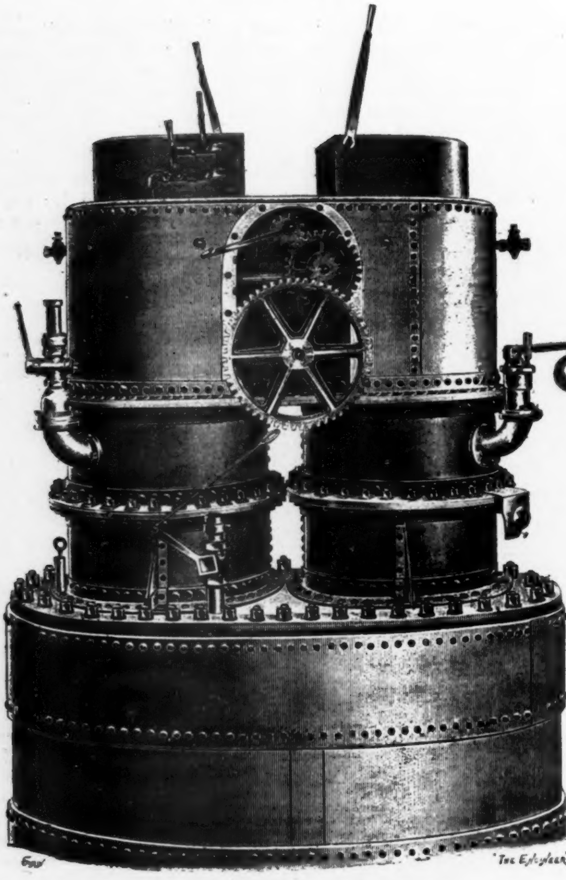
Fig. 1
General Section



in one piece. The first 5 ft. 6 in. from the bottom upwards was formed of two thicknesses of $\frac{3}{4}$ in. plates riveted together, with rivets countersunk on the outside, and with the usual cutting edge at the bottom of the cylinder. On the inside were angle iron knees supporting a shelf 5 ft. from the bottom, and closing an annular space between the outside cylinder, which was 11 ft. 4 in. internal diameter, and an inner cylinder 8 ft. in diameter, thus leaving the annular space exactly half the area of the whole cylinder, or 50 square feet. When this space was afterwards filled in with concrete, weighing approximately twice the weight of water, it was sufficient to balance the cylinder and compensate for the buoyancy created by the exclusion of the water by the compressed air.

The inner cylinder was made of $\frac{1}{2}$-in. plates and the outside with the exception of the bottom 5 ft. 6 in., was made of $\frac{3}{8}$-in. plates, riveted together and stiffened with angle iron rings. With the exception of the bottom length of 15 ft. the outer cylinder was made in sections 8 ft. long, with angle iron rings at either end for the purpose of joining them together with 1 in. bolts. Owing to the large number of cylinders, and their comparatively short distances from one another, it was deemed expedient, in view of the rough weather to be contended with, to erect a temporary timber staging for placing the cylinders, rather than employ any other method which might have presented various inconveniences in the transport of concrete and other material. On this timber staging, which, owing to the nature of the case, was in itself a work of some magnitude, six timber guides, 15 in. by 12 in. by 14 ft. long, were securely placed at the exact site for each cylinder. It was also furnished with three lines of rails for 45 ton traveling cranes, and with four lines of metre gauge for trucks used in transport of concrete and in the removal of the excavated material, &c. The staging was 25 ft. high above water level, and was made of piles 12 in. by 12 in. stiffened with diagonal bracing above and below water.

The operation of sinking a cylinder was as follows :—Heavy temporary timbers having been placed on the lower part of the stage at about water level, forming a strong platform between the guides previously referred to, the bottom length of 15 ft. was brought from the shore by means of a traveling crane, and deposited on it. The inner and outer cylinders were then built up to a height of 39 ft., and weighing altogether close on forty tons, were lifted by means of the traveler to a sufficient height to enable the timbers on which they rested to be withdrawn. The whole cylinder was then lowered into the sea until it floated by reason of the annular space between the inner and outer cylinders. A wrought iron cover was then placed over the inside



Hughes Air Lock—Valparaiso Harber.

cylinder, the joint being made air-tight by means of inch bolts and packing. On this cover two lengths of 3 ft. diameter shaft cylinders were bolted, and other lengths of these and of the outside cylinder were added, till the whole rested on the bottom with the top of the cylinder rising above the upper stage. As the cylinder sank the annular space was filled in with Portland cement concrete 3½ to 1 up to the height of the cover, and the concrete continued above that in the same form by means of temporary curbing. It was mixed by hand on bankers designed for the purpose, and placed one on either side of the cylinder, the material being brought from the shore in small tip wagons.

The cylinder in this position was ready for the reception of the bell or pneumatic apparatus proper. A section and elevation of this is given in Figs. 2 and 3, from which it will be seen that it consisted of a wrought iron case with semi-circular ends made to fit on to the shaft cylinders, and was designed with a view of requiring no men under pressure except those actually engaged in excavation. The air locks were formed as follows :—The two D shaped cases marked A were furnished with covers or flaps worked from the outside by means of a hand lever fixed on the bar forming the hinge, which passed out through a small stuffiing-box, the joint between the cover and the top of the case

being made air-tight by means of an india-rubber ring attached to the former. A similar ring was fastened underneath the bottom of the D-shaped case for the purpose of forming an air-tight joint with the bottom portion of the air lock or skip case marked B. This was suspended by two chains of gauge links, one on either side, passing round the chain sheaves marked C, so that when both the D-shaped chambers were closed and the compressed air admitted, one skip case could be raised and the other lowered simultaneously by means of the winch worked on the outside, the main shaft of which passed from side to side of the air bell through stuffing-boxes and carried the driving sheaves—marked C—on the inside. It was the top of either of the skip cases marked B coming in contact alternately with the rubber ring on the bottom of A which made the joint complete and allowed the air lock thus formed to be opened by letting the compressed air escape from the inside of it. The cocks for the inlet or outlet of compressed air to the air locks were 1½ in. bore, and linked together so as to be worked by one lever, controlled on the outside by the man in charge Smaller cocks, ¼-in. bore, were provided on the inside, to be used by the workmen coming in or out, so that they could control the rapidity of the change of pressure to suit themselves.

The buckets or skips for hoisting the excavated material were made to fit closely the inside of the skip case, and a convenient method of attaching a chain for emptying them was arranged by means of a pipe passing through from side to side of the bucket close to the bottom. Through this pipe a short bar of iron was thrust as it was raised from the air lock by a steam crane. The iron bar projected sufficiently on either side to admit of the attachment of the tripping chain.

The air bell was furnished with a signal gong, pressure gauge, safety valve, and air supply connections, with check valve and stop cock, as an additional precaution to be used in the event of a breakage in the hose joining the air supply pipe and the air bell. There was also a 3 in. cock in the cover of the 8 ft. cylinder for use in case of its being necessary to eject water from the cylinder otherwise than by forcing it through the bottom. Means were provided also for attaching a small flexible pipe for drawing off compressed air for working a pump to supply water for the concrete. The arrangement was completed with a small wire rope ladder hung from beside the air locks, and reaching nearly to the bottom of the cylinder, to enable the men to go up or down in case the machinery required adjustment in any way. It was at first intended to work the hoisting and lowering by compressed air by fitting steam cylinders to the winch on the outside, but labor being cheap enough, it was not thought necessary. The compressed air was furnished by means of a stationary engine on shore, with two air pumps, 15 in. diameter, 2 ft. 8 in. stroke, surrounded by tanks of flowing water to keep them cool. It was led thence by iron pipes to within a few feet of the cylinders, the connection with them being made with a flexible hose, 3 in. internal diameter. As a rule, two foundations were sunk simultaneously. As the excavated material was removed from the bottom edge, the cylinders generally followed down by their own weight, but it was sometimes found necessary to let all the compressed air escape from the inside, and thus get rid of the buoyancy caused by the displacement of the water by the compressed air.

The great increase of weight brought into play by this means generally resulted in the cylinder sinking rapidly to a depth of 5 ft., 6 ft., or more at a time, but there was always the risk of a considerable quantity of sand, etc., being forced in by the inrush of water from below.

When the cylinders were sunk to the required depth—which in some cases amounted to 107 ft. below water—some 8ft. or 10 ft. of concrete was put in carefully, and the air pressure maintained till it set.

It was during the hardening of this concrete that the chief use was made of the safety valve, which, by maintaining the pressure at a certain point, obviated the possibility of compressed air blowing out at the bottom of the cylinder, and so causing unsound work or troublesome leaks in the concrete.

The concrete put in under pressure was placed directly in the skip cases, which were tipped like buckets inside the cylinder, so that no buckets or skips were required.

When it was sufficiently hardened, the pneumatic apparatus, including the cover of the 8 ft. cylinder, was removed, and and the whole of the cylinder filled up with concrete 8 to 1, cast in from above. Two men were employed under pressure at a time in each cylinder, working four hour shifts ; and in some cases the usual

results of working under compressed air were noted, viz., bleeding at the nose and ears, headache, rheumatic pains, etc., but with one exception—there were no fatalities. In one case fatal results followed from the neglect of a workman to give the usual signal that it was a man and not material that was coming out. The consequence was that the pressure was released suddenly, and he found himself paralysed from the waist downwards. He at once went again under pressure, and came out gradually; but the mischief was already done, and the attempted remedy was of no avail. He died in hospital some three months afterwards from the indirect effects of the paralysis.

As a rule two cylinders were being sunk under pressure at the same time as two others were got ready for the operation.

*Experiences with Compressed Air in Ship-building and Ship-Yard Work.

BY WILLIAM BURLINGHAM.

Of late years great advances have been made in the use of compressed air as a motive power for small tools, and it is already considered on an equality, and for many operations, superior to steam, electricity or hydraulic power.

Practically all the large railroad and ship-building plants in the country have adopted this form of power in a greater or less degree. It is possible to convey it from point to point with great facility and practically no drop in the pressure, though the pipes may be very long. For example at the Jeddo Tunnel, in Pennsylvania, air at 60 lbs. pressure was carried 10,860 feet, and the gauges at both ends of the pipe showed no difference in pressure. There are many other instances of this kind, where it would be practically impossible to convey steam, and consequently a small boiler with fireman would be necessary at the scene of operations. Other advantages are that it lends itself for use in all kinds of holes and corners. There is very little, if any, danger from frost, if the pipes are properly laid, protected and drained. There is no chance of short circuits or unforeseen shocks; no solenoids or delicate armatures to get out of order and no heavy mass of iron and copper to transport in the shape of an electric motor, for the purpose for instance, of drilling a ¾ in. hole. There are no leaky joints as in hydraulic motors, and no trouble from condensation and lack of positive movement as in steam.

Its economy is equal, if not superior, to any of the existing prime movers, if used with judgment and due regard for its capabilities and for the right tools; that is, for those various small tools that are located at a considerable distance from the source of power, operating in many different places in a short interval of time.

It is the general opinion that air, water and steam are pre-eminently suited for pressure operations or where blows are to be delivered, and electricity for rotary motion. Experience, however, has taught that for hand tools, both rotary and reciprocating, the air engine has most advantages in establishments where light and easily handled tools are a necessity.

The fact that an ordinary mechanic can repair and adjust air motors, while it requires an expert electrician to repair an electric motor, would seem to make it preferable to use the former method, as ordinary mechanics are more numerous in a shipyard than expert electricians.

Compressed air should be used and not abused. Small leaks are very prevalent in the piping, valves and loose couplings, and worn out motors often consume an excessive quantity of air. These are very small matters in themselves, but taken collectively in a large plant, have a very depressing effect upon the coal pile and an elevating one on the expense account. Treat the air plant with the same care that is manifested in the insulation of electric wires or lagging of steam pipes and there will be less grumbling heard concerning the wastefulness of the system. A committee of the Master Mechanics of the principal railroads of this country reported at the last meeting, 1897, that the use of compressed air, with suitable apparatus, gave an average economy of from 25 to 50 per cent. over the ordinary former practice, in their shops, on the following work:

Tapping out stay bolt holes, reaming and drilling holes, chipping and caulking, removing tires, beading flues, air hoists, vertical and horizontal car jacks, tinware presses, shears erected outside shop for shearing off test coupons, tank riveters, shears at scrap pile, shears for light sheet iron work, small Pelton wheels for operating emery wheels, blast for blacksmith forges, applied to mixing paint in large quantities by putting a pipe in bottom of mixing barrel, used in all kinds of motors for boring cylinders and facing valves,

*Marine Engineering.

cleaning cushions inside and out of cars, blowing out cylinders before inserting packing, rolling flues, swedging flues, testing brakes and numberless other minor purposes.

The following particulars were given of a shop turning out sixty engines per year, viz: One compressor with 15-in. steam, 14-in. air cylinders and 18-in. common stroke, five elevators, one hoist for driving wheel lathe, six hoists for lathes and planers, two Brotherhood engines, three motors, one sand elevator, one fire kindler and one flue cleaner. The cost of this compressor, including foundations and pipe connections, was $1,260.50. Pipe lines, hose, valves, reservoirs, motors, hoists, elevators, cost $1,189.50. A total of $2 450.

On a test run of eight hours it required 313 lbs. of coal per hour or 2,508 lbs. for the run. Pressure was raised from zero to 120 lbs. in 5 minutes, 40 seconds. The compressor made 858 revolutions and compressed 2,681.6 cu. ft of free air to 193.9 cu. ft. of air at 120 lbs It required with this compressor 20.4 lbs. coal to compress 1,000 cu. ft. of free air to 120 lbs , equaling 60 per cent. of its theoretical capacity. The packing of this engine had not been overhauled for eighteen months, thus accounting for some of the deficiency.

It is during the building of a ship that the advantage of these power tools are best exemplified A hull is full of odd corners and nearly inaccessible nooks that must be as well riveted and caulked as the most accessible part of the vessel; perhaps better as it is more difficult to overhaul and examine these places.

It is not so long ago that the best yards in the country depended upon the racket drill and hand riveting, the work having to be done in such inconvenient places and uncomfortable attitudes upon the part of the workmen as to preclude the possibility of a first-class job. Now from the driving of the first rivet in the keel to the launch of the vessel the continuous clatter of air riverters, caulking tools and the whirring of rotary drills are sure indications of rapid progress toward completion.

Pneumatic Drill, in Shipyard Work.

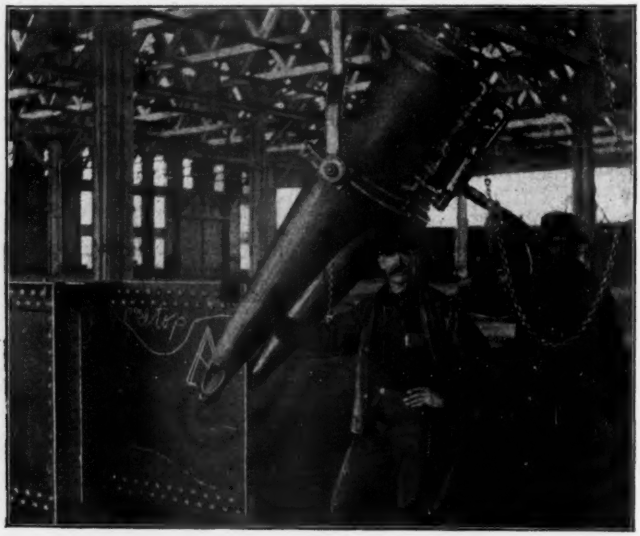
Probably one of the largest and best equipped air plants for the use of small tools is located at the works of the Newport News Shipbuilding and Dry Dock Co. Comparatively new, this air plant now furnishes the power for the majority of the tools used on the outside work of the various naval and merchant vessels building there, to the exclusion, almost, of steam and electricity.

The original plant consisted of a small Rand compressor and a few tools; then a couple of Pedrick and Ayer compressors

and more tools were added. Now, hardly more than three years since the starting of the initial plant, there are in operation two large Ingersoll-Sergeant compressors, viz:

One class G, duplex compound compressor with 20-in. steam cylinders, 20¼-in. high pressure air cylinder and 32¼ in. low-pressure air cylinder and 24-in. common stroke. This engine has a receiver inter-cooler 36-in. dia. by 9 ft. 6 in. long, and discharges 2,200 cubic feet free air per minute at 100 lbs. pressure.

One class G, duplex compressor, with 20-in. dia. steam and 20¼-in. dia. air cylinders and 24-in. common stroke, with a capacity of 1,600 cu. ft. of free air per minute and 100 lbs. pressure at discharge.



Pneumatic Portable Riveter, in Shipyard Work.

These compressors are all made with the piston inlet air cylinders, are water jacketed and are furnished with a governor automatic pressure regulator. The compressed air is discharged into a storage tank common to all at about 90 lbs pressure.

The storage tanks are a necessity and should be of such size as to enable the engines, after once filling them, to run at a moderate speed during working hours.

The tanks are usually provided with pop safety valves, ample drainage, and from the first tank a small pipe is led back to the automatic regulator on the engine. From this main tank the air is carried by mains to smaller storage tanks located at different points in the yard, nearest the centres of work

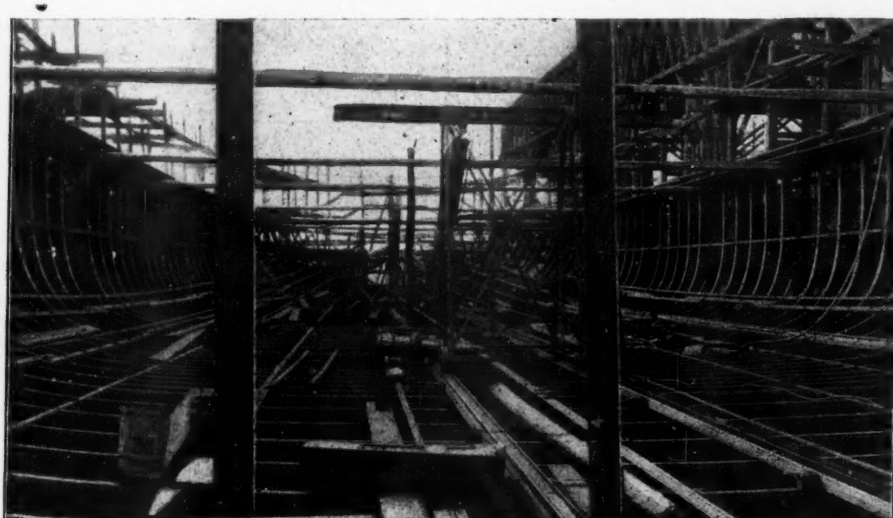
By constructing the storage tanks with a baffle plate down the center, the air entering at the top impinges upon the plate, delivering the entrained water into the bottom of the tank, from whence it is drained at intervals. The air then passes under the baffle plate and out again at the top of the tank. The air pipes should always enter and leave the storage tanks at the top.

The drawing on page 515 is a plan of the yard piping. The main air pipe is about 1,500 ft. long, of cast iron, with leaded joints, 8 in. inside dia. and reduced at intervals to 6-in. and then to 5 in. At the end it enters a reheater similar to a surface condenser about 27-in. dia. and 6 ft. long, with wrought iron tubes 1¼-in. dia., and is there heated by the exhaust steam from one of the shop engines. This reheated air is employed to run a regular type Atlas horizontal steam engine that furnishes power for a large band sawmill. The exhaust

air from this engine is employed to force the sawdust from the mill as it acccmulates. The device is shown on page 516. The air pipe to the engine is 3½-in. dia. and the exhaust 4½-in. dia. The reheater also supplies air to a small motor for a saw grinding machine.

At any point in this system the pressure gauge will register the same as at the main tank, and even under the most unfavorable circumstances there is but little appreciable drop. There are four other mains leading from the storage tank, two 4-in., one 3-in. and one 2½-in., all wrought iron pipe with screwed joints. All pipes used the use of air, freedom from breakdown and the not least important absence of vibration. Indeed, some tools which work satisfactorily in the first two named respects, are very severe on the workmen. They are all liable to break in one part or another, but the manufacturers are constantly improving and strengthening the weak parts as they are taught by experience.

The pneumatic riveters are a little larger than the hammers or caulkers, with a head that fits the head of the rivet. The work of driving the rivet is done by a large number of comparatively light blows instead of a single squeeze as in a hydraulic machine.

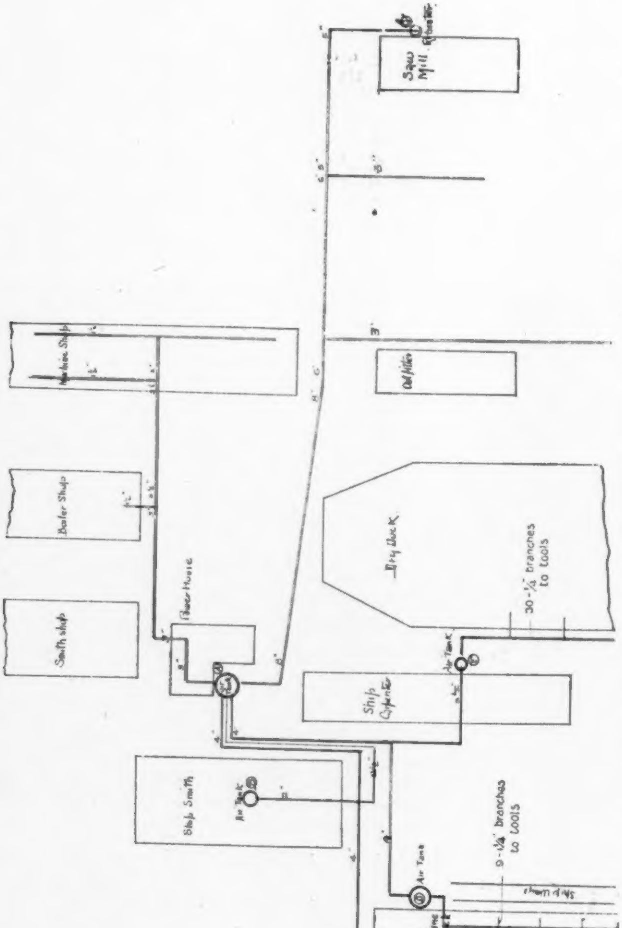


Portable Riveter in Operation.

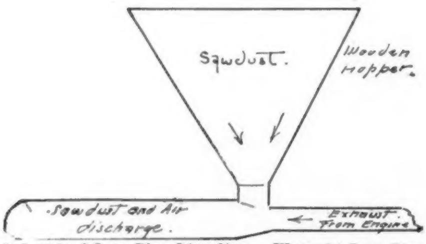
in connection with this plant are buried in trenches below the frost line.

The 2½-in. main has supplied power sufficient for twenty-eight No. 2 Boyer hammers and four drills, but this was the full working limit of the pipe; about two-thirds this number would be a preferable load. The hammer supply nozzle is ¼-in. and the drills ⅜-in. pipe taps. The yard has used nearly every type of pneumatic machine that is manufactured and even now have many different types in use.

Some of the different operations performed by the tools are shown in the group picture on page 516. In everyday use many of the tools work more satisfactorily than others, in the matters of economy, in This permits of the use of a very light frame for holding the riveter. The latest type is that patented by the Detroit Dry Dock Company, and is made of 2½-in. W. I. gas pipe, bent to a U shape, with a gap of about 60 in. This frame enables the workman to reach rivets that are absolutely unapproachable otherwise than by hand riveting. Nearly all makes of pneumatic drills are practical; some are more powerful than others for the same weight. Their great difference is in their economy. All are extremely liable to breakage in some minor points, and a small repair shop is a necessity where many pneumatic tools are used. The drills are made in three types, the movable cylinder, the movable



System of Compressed Air Piping at the Newport News, Va., Shipyard.



Galvanized Iron Pipe 8 in. diam. Wrought Iron Pipe 4½ in. diam.

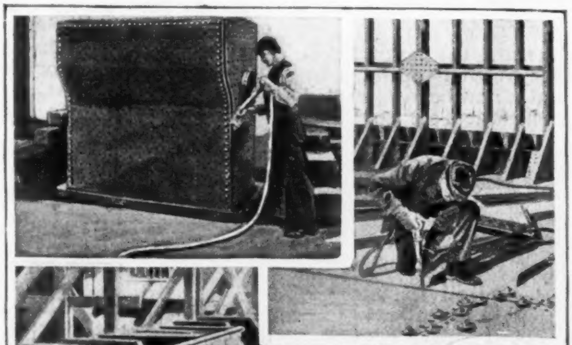
Pneumatic Sawdust Ejector.

piston and the rotary, similar to the rotary pump; these last are great consumers of air and are not to be recommended where economy is a feature. The movable cylinder type, at the present date, seems to be the most economical and is at the repair shop the least of often, considering the amount of work done by it.

It is necessary that care be taken to keep these machines clean, well oiled and in good working order. Proper lubrication is an essential requirement, both as to quality of oil and frequency in applying it. The best winter strained lard oil or valvoline sewing machine oil are recommended. Should it become necessary to clean the machine, admit kerosene and turn slowly while the grease is dissolving and when all is dissolved admit air through the throttle. Thoroughly lubricate again before using.

As these machines are made interchangeable, the parts most liable to break should be duplicated in store. These cost but little and afford a most excellent insurance against stoppage from breakdowns.

For work in the frame sheds, on bulkheads and reverse frames the Caskey or single squeeze pneumatic riveter is used. This is a very good and efficient tool; it is usually slung from a jib crane with a long jib, by a chain twist, and thus commands a large area.



Chipping, Caulking and Riveting with Pneumatic Tools.

The larger illustration on page 514 shows this riveter at work on the double bottom of a battle ship. A track was laid down the center of the inner bottom. This was for the crane carriage. The riveter, as shown,

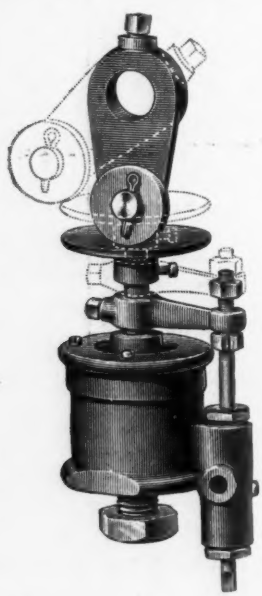
is held by a pneumatic hoist. This was found to be a poor arrangement, as the elasticity of the air in the pneumatic hoist prevented a rapid setting of the hammer on the rivet. A Weston chain hoist was afterward used with success.

For general work about the yard a see-saw arrangement was devised, consisting of a beam, supporting the riveter at one end, with a counter balance at the other. The beam rested on an A frame carriage. This allowed a great latitude of movement and was eminently successful. It is shown on page 513.

The amount of work done by these pneumatic machines is greatly dependent upon the workman, and the men must be picked by actual trial to secure the best results.

Locomotive Bell Ringer.

The cut herewith shows the Bartow Locomotive Bell Ringer which is operated by compressed air, and is now being marketed by the Chicago Pneumatic Tool Co. This



has been in use for about two years on several railroads in the East, with the very best of success.

The motor for ringing the bell has no direct connection whatever with the bell, the crank of the bell shaft having a roller which works over the disc shown on motor. The valve is operated from an arm, extending from the piston rod to the valve rod, and two adjustible nuts, one above and one below this arm, adjust the length of the stroke of valve. This also regulates the speed at which the bell is rung.

There are very few parts to this bell ringer, and in the two years' service they have been in, there have been no repairs. It is easily placed on the engine by a small bracket on the bell frame. The simplicity of the machine can be easily seen, also the economy in running it, the stroke being very short, and only 1¾ in. in diameter. It is operated by air from the main reservoir on the engine, and is rung from a valve placed in the cab.

It has been shown that on an engine equipped with a bell ringer, the saving in consumption of fuel has been enough in one month to pay for the device. The explanation of this is that the fireman has so much more time to attend to the firing of the engine, instead of looking out of the window and watching for crossings to ring the bell.

This little device is going to meet with favor among railroad men.

Our outside cover illustration this month is a compressed air drilling machine made by the C. H. Haeseler Co., of Philadelphia. Several machines of this type are used by the Union Switch and Signal Co., for the purpose of drilling the ends of rails in railroad yards where compressed air is available.

The machine has a capacity for drilling holes up to ⅞" in diameter and will drill such a hole through the web of a rail ½" thick in less than half a minute.

The motor consists of three reciprocating pistons, working in the same number of cylinders, and is of the latest design. It is very efficient, and strongly made, and as will be noted, is rigged with power feed, operated by hand, requiring but little effort on the part of the operator to force the drill into the work.

ALPHABETICAL LIST OF PNEUMATIC INVENTIONS

For which United States patents have been granted. Prepared for COMPRESSED AIR from official records by GRAFTON L. M'GILL.

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	No.
Air Compressor	Henderson & Schutz	May 17, 1892	475,111
"	Hill	Nov. 4, 1890	439,876
"	"	March 24, 1891	448,859
"	"	May 12, 1891	452,132
"	"	June 23, 1891	454,590
"	"	Nov. 17, 1891	463,386
"	"	Nov. 24, 1896	571,971
"	"	Nov. 2, 1897	593,049
"	Hutchinson	Aug. 16, 1892	581,143
"	Kalthoff	Dec. 17, 1895	551,549
"	Keenan	Oct. 8, 1895	547,519
"	Knight	July 13, 1897	586,100
"	Knoche	Nov. 7, 1893	508,225
"	Liming	Oct. 20, 1896	569,929
"	Lowe & Guyser	Feb. 19, 1895	534,399
"	Massey	Aug. 12, 1890	433,951
"	Merritt	June 23, 1896	562,475
"	Miles	Oct. 5, 1897	591,137
"	Moore	Sept. 18, 1883	285,297
"	"	Dec. 23, 1884	309,642
"	Monson	Oct. 20, 1885	328,598
"	Moyer	July 2, 1895	541,979
"	Nichols	Feb. 25, 1896	555,178
"	"	Aug. 31, 1897	589,190
"	Noack	Nov. 26, 1895	550,352
"	Nordberg	Sept. 1, 1891	458,975
"	Norris	Dec. 30, 1884	310,148
"	North	Oct. 9, 1894	527,248
"	Nosbaume	Nov. 20, 1888	393,172
"	Noyes	July 14, 1896	563,794
"	O'Brien	June 21, 1892	477,381
"	Overton	Aug. 22, 1882	263,206
"	"	Aug. 22, 1882	263,207
"	Parkinson	March 2, 1880	225,151
"	Pedrick	Aug. 13, 1895	544,548
"	Pendleton	June 2, 1896	561,126
"	Perine	April 13, 1897	580,714
"	Perry	Nov. 8, 1892	485,881
"	"	June 6, 1893	498,989
"	Pfanne	March 25, 1884	295,800
"	Phillips	May 12, 1891	452,283
"	Pitchford	May 20, 1879	215,540
"	"	Oct. 19, 1880	233,432
"	Pitt	July 10, 1888	386,028
"	Quast	July 4, 1893	501,046
"	Quinn	Jan. 11, 1881	236,455
"	Rand	March 21, 1882	255,116
"	Rand & Halsey	Feb. 18, 1890	421,611
"	Reynolds	Feb. 27, 1877	187,906
"	"	Feb. 20, 1883	272,771
"	"	Feb. 21, 1888	378,336

ALPHABETICAL LIST OF INVENTIONS.—*Cont.*

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	No.
Air Compressor	Reynolds	March 16, 1875	160,956
"	"	Aug. 1, 1882	262,119
"	"	Dec. 1, 1896	572,377
"	Richards	Nov. 10, 1891	462,776
"	Richmann	June 29, 1880	229,468
"	"	Sept. 15, 1891	459,527
"	"	Nov. 3, 1891	462,453
"	Rix	Dec. 7, 1880	235,296
"	"	Dec. 21, 1880	235,816
"	Roberts	Dec. 1, 1896	572,314
"	Robinson & Kiser	Oct. 11, 1881	248,218
"	Root	Oct. 16, 1877	196,253
"	Sawtell	Oct. 24, 1876	183,596
"	Schutzinger	Nov. 7, 1893	508,150
"	Schutz & Henderson	April 3, 1894	517,628
"	Seal	March 14, 1876	174,860
"	"	Sept. 19, 1876	182,333
"	Sergeant	Nov. 2, 1880	233,881
"	"	Sept. 19, 1882	264,775
"	"	Nov. 26, 1889	415,822
"	"	March 10, 1891	447,910
"	"	July 21, 1891	456,165
"	"	Feb. 13, 1894	514,839
"	"	Dec. 11, 1894	530,662
"	"	Oct. 6, 1896	568,804
"	"	March 30. 1897	579,775
"	Shaw	Jan. 7, 1896	552,590
"	Shedlock	July 20, 1897	586,669
"	Sherman	May 17, 1892	475,251
"	Smith	Dec. 26, 1882	269,730
"	"	Dec. 1, 1896	572,383
"	Spencer	April 15, 1879	214,465
"	"	Aug. 17, 1897	588,296
"	Springer	Dec. 17, 1878	211,062
"	Stambaugh	Oct. 22, 1895	548,399
"	Stockman	Nov. 23, 1880	234,733
"	Strange	Nov. 15, 1887	373,419
"	Sturgeon	Aug. 8, 1876	180,958
"	"	April 17, 1883	275,959
"	Swartz	May 18, 1886	342,310
"	Tallman	April 11, 1876	176,096
"	Tatham	Dec. 23, 1879	222,802
"	Taylor	July 23, 1895	543,410
"	"	July 23, 1895	543,411
"	"	July 23, 1895	543,412
"	Teal	May 3, 1892	474,034
"	Toennes	Feb. 9, 1897	576,920
"	Thomas	March 2, 1886	337,209
"	"	July 22, 1879	217,834
"	Treat	Oct. 28, 1879	221,126
"	Underwood	April 14, 1896	558,125
"	Wang	March 21, 1882	255,222
"	"	April 4, 1882	255,901
"	"	Aug. 1, 1882	262,157
"	Walker	Feb. 7, 1893	491,232

Patents Granted July, 1898.

Specially prepared for Compressed Air from the Patent Office files by Grafton L. McGill, Washington, D. C.

607,655—Process of and Apparatus for Generating Power from Compressed Cases. E. N. Dickerson, New York, N. Y.

A liquefied gas is first produced after which the pressure is released and the gas expanded, preferably through a motor, thus cooling the gas. The gas is then transmitted to an explosion chamber to cool the latter, after which the gas is combined with air and explodes the mixture in said chamber.

608,095—Air-Brake. C. L. Ansley, Atlanta, Ga.

This invention relates to a triple-valve device. Means are provided for passing the air around the main piston of the triple-valve when the brakes are applied, the piston being held in this position to restore air pressure in the auxiliary air reservoir before discharging the brake-cylinder by an automatic pneumatic retaining device made in the form of a casing and a piston. In both positions of the piston its sides are exposed to the auxiliary pressure of the air reservoir. Its opposite sides are exposed to unequal areas of pressure when the brakes are applied and to equal areas when released.

608,030—Air-Brake. Murray Corrington, New York, N. Y.

A check-valve is opened by train-pipe pressure on the opening of the emergency valve, while a second valve, operated by the check-valve, but independent thereof, controls a vent port from the train-pipe to the atmosphere.

August, 1898.

609,087—Air Compressor. C. N. Dutton, New York, N. Y.

This invention has for its object the compression of air by means of the impact of falling water, thereby dispensing with compressing pistons and other actuating mechanism. An automatic valve mechanism is provided by which water is allowed to be intermittently discharged with as nearly as may be the full velocity due to its head, into an air compression chamber, in which it acts by impact to compress a charge of air. The force being delivered as a blow upon the elastic cushion of air to be compressed the degree of compression may be made as high as desired by suitably proportioning the compression chamber and its delivery end to the volume of water employed at each impulse and its velocity. The air is compressed into a suitable reservoir, and confined therein by a check valve, while means are provided for intermittently drawing the waste-water out of the compression chamber and allowing a new volume of air to enter to be compressed by the next succeeding discharge of water.

609,088 — Air Compressor. C. N. Dutton, New York, N. Y.

This invention contemplates the compression of air at one stage from atmospheric pressure to as high a degree as may be desired. The appliance embodies a compressor cylinder, a water-packed piston fitted to reciprocate therein, and a compressor chamber communicating directly with the compressor cylinder. An air reservoir is also provided, being connected by a valve-controlled passage to the compression chamber. A release valve is open during the initial portion of the compressing stroke of the piston and is closed when the piston has attained its maximum velocity.

608,964—Air Compressor. Heston & Harvison, Rushland, Penn.

A series of cylinders having pistons are secured to a fixed hollow shaft, on which are side-wheels having a driving pulley. Rollers mounted on these wheels are adapted to run on a series of track levers connected with the pistons. Thus as the side wheels are revolved the rollers depress the pistons, which are returned by spring mechanism.

608,599—Air Brake. F. L. Guillemet, San Francisco, Cal. Assignor to the Westinghouse Air Brake Co., Wilmerding, Pa.

The piston is exposed on opposite sides of its face to fluid under pressure. A valve is operated by said piston for releasing fluid under pressure from the auxiliary reservoir to the break cylinder and controlling a passage through which such fluid is released from the train pipe side of the piston to effect an emergency application of the brakes.

608,600—Air Brake. F. L. Guillemet, San Francisco, Cal. Assignor to the Westinghouse Air Brake Co., Wilmerding, Pa.

A valve, controlling the passage of fluid under pressure from the auxiliary reservoir to the brake cylinder, is located on the reservoir side of, and operated by the piston. The piston is exposed on its opposite sides to pressure from the train pipe and auxiliary reservoir, respectively, while an exhaust valve, located on the train pipe side of the piston, controls the passage from the brake cylinder to the atmosphere.

608,621—Air Brake. H. S. Parke, Chicago. Assignor to The Westinghouse Air Brake Co., Pittsburg, Pa.

The main chamber of a triple valve has a port in its casing which communicates with the train pipe and said chamber. The main valve is also provided with a valve controlled port which is adapted to register with the port in the casing. Thus the main valve chamber and the auxiliary reservoir may be charged from the train pipe through the main valve.

609,041—Air Brake. John J. Nef, New York, N.Y.

This invention consists of an air reservoir, a pump and operating means therefor. The brake cylinder is controlled by a service valve, while the pump is thrown into operation by the exhaust from the brake cylinder when the brakes are released. The pump is thrown out of operation by the pressure of air in the reservoir.

609,042—Air Brake. John J. Nef, New York, N.Y.

A governor is employed in connection with the pump, for connecting and disconnecting its operating mechanism. Means are provided for opening the compression chamber of the pump to the atmosphere while the pump operating mechanism is being connected with the pump.

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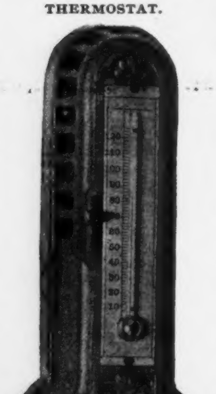
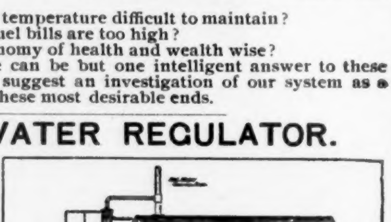
THERMOSTAT.



Do you desire an even temperature in your house and office?
Do you consider an even temperature conducive to health and comfort?
Do you find an even temperature difficult to maintain?
Do you think your fuel bills are too high?
Do you consider economy of health and wealth wise?

We assume there can be but one intelligent answer to these queries, and would suggest an investigation of our system as a means of attaining these most desirable ends.

HOT WATER REGULATOR.



Attach it to your hot water tank and it will save *you* fuel and your *engineer* trouble.

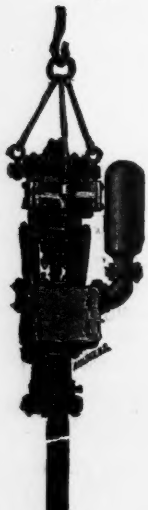
It assures a regular and even supply of hot water, and by preventing over-heating avoids all possibility of the straining of water pipes or faucets, and the cracking of basins or tubs.

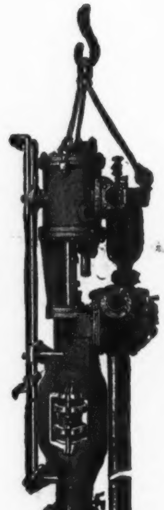
The Davis & Roesch Temperature Controlling Co.,
Treasurer's Office, Havemeyer Bldg., 26 Cortlandt St., New York, Factory, Bridgeport, Conn.

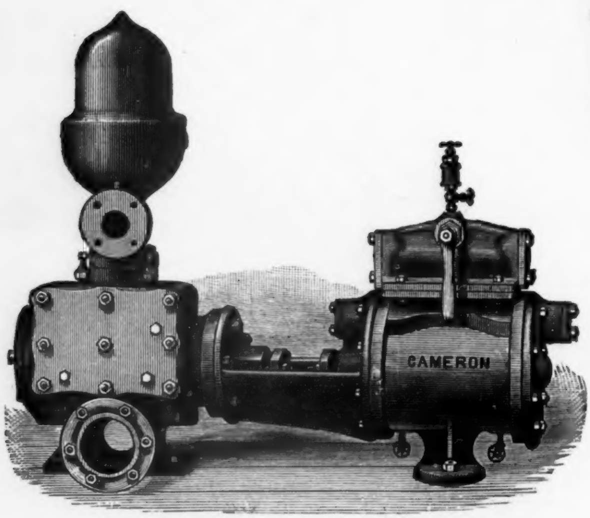
CAMERON STEAM PUMPS.

Simple,
Compact,
Durable,
Efficient.

NO OUTSIDE VALVE GEAR.







ADAPTED TO EVERY POSSIBLE DUTY.

MANUFACTURED BY

THE A. S. CAMERON STEAM PUMP WORKS,

Foot East 23d Street, New York.